

What is claimed is:

1. An ultrasonic diagnostic device that generates and displays an ultrasound image containing an object which is subject to examination in accordance with reflection of ultrasound, the

ultrasonic diagnostic device comprising

an automatic contour extracting means for extracting a final contour of the object from the ultrasound image by performing a predetermined operation on the ultrasound image,

wherein for performing the predetermined operation, the automatic contour extracting means includes:

an initial contour extracting unit for roughly extracting an initial contour of the object; and

a dynamic contour extracting unit for accurately extracting the final contour by using the extracted initial contour as an initial value and by applying an active contour model to the object within the ultrasound image.

2. The ultrasonic diagnostic device of Claim 1, wherein the dynamic contour extracting unit calculates an optimum solution for the active contour model by performing iterative operation to extract the final contour.

3. The ultrasonic diagnostic device of Claim 1, wherein the automatic contour extracting means also includes

an initial contour correcting unit for judging whether the extracted initial contour meets a predetermined standard and for correcting the initial contour when judging that the initial contour does not meet the predetermined standard,

wherein the dynamic contour extracting unit extracts the final contour by using the corrected initial contour as an initial value.

4. The ultrasonic diagnostic device of Claim 1, wherein the

automatic contour extracting means also includes

an initial contour selecting unit for storing a criterion in advance and selecting an initial contour meeting the criterion from a plurality of extracted initial contours when the initial contour

5 extracting unit extracts the plurality of initial contours,

wherein the dynamic contour extracting unit extracts the final contour by using the selected initial contour as an initial value.

10 5. The ultrasonic diagnostic device of Claim 4, wherein when a plurality of extracted initial contours meet the stored criterion, the initial contour selecting unit selects the plurality of extracted initial contours.

15 6. The ultrasonic diagnostic device of Claim 1, wherein the automatic contour extracting means also includes an external selection unit for selecting at least one initial contour from a plurality of initial contours in accordance with dialog with an operator when the initial contour extracting unit extracts the plurality of initial contours,

20 wherein the dynamic contour extracting unit extracts a final contour in accordance with the at least one selected initial contour as an initial value.

25 7. The ultrasonic diagnostic device of Claim 1, wherein the initial contour extracting unit includes:

a density value adjusting unit for performing equalization on the ultrasound image to enhance contrast of the ultrasound image;

a binarization unit for converting the equalized ultrasound image into a binary ultrasound image; and

30 a degenerating unit for performing a degenerate operation on the binary ultrasound image.

8. The ultrasonic diagnostic device of Claim 1,
wherein the automatic contour extracting means also includes
an initial contour input unit for obtaining an initial contour
that roughly specifies the object in accordance with dialog with an
operator,

wherein the dynamic contour extracting unit extracts a final
contour by using the obtained initial contour as an initial value.

9. The ultrasonic diagnostic device of Claim 8,
wherein the automatic contour extracting means also includes
a contour selecting unit for selecting one of the initial contour
obtained by the initial contour input unit and the initial contour
extracted by the initial contour extracting unit,

wherein the dynamic contour extracting unit extracts a final
contour by using the selected initial contour as an initial value.

10. The ultrasonic diagnostic device of Claim 1, wherein when a
time required to extract the initial contour is $t1$ and a time required
for the dynamic contour extracting unit to extract the final contour
is $t2$, an expression $t1 \geq t2$ is satisfied.

11. The ultrasonic diagnostic device of Claim 1, wherein when a
time required to extract the initial contour is $t1$ and a time required
for the dynamic contour extracting unit to extract the final contour
is $t2$, an expression $t1 \leq t2$ is satisfied.

12. The ultrasonic diagnostic device of Claim 1, further
comprising an automatic capacity calculating means for calculating
a capacity of the object by using the extracted final contour.

13. The ultrasonic diagnostic device of Claim 12,
wherein the automatic contour extracting means extracts a

contour of a left ventricle of a heart as the final contour and
wherein the automatic capacity calculating means calculates
a capacity of the left ventricle.

5 14. The ultrasonic diagnostic device of Claim 13, further
comprising a measurement display means for displaying the
calculated capacity.

10 15. The ultrasonic diagnostic device of Claim 14, further
comprising
a real time control means for having an operation repeatedly
performed at a fixed frame rate, the operation including: (a) the
extraction of the final contour by the automatic contour extracting
means; (b) the calculation of the capacity; and (c) the display of the
15 calculated capacity.

20 16. The ultrasonic diagnostic device of Claim 15, further
comprising
an image display means for displaying at least one of the
ultrasound image and the final contour,
wherein the real time control means controls the image
display means and the measurement display means so that the
calculated capacity is displayed in synchronization with the display
of the at least one of the ultrasound image and the final contour.

25 17. The ultrasonic diagnostic device of Claim 16, wherein the
measurement display means displays the calculated capacity by
superimposing the capacity over the at least one of the ultrasound
image and the final contour.

30 18. The ultrasonic diagnostic device of Claim 17, wherein the
measurement displaying means displays the capacity while leaving

previously calculated capacities displayed to thereby display transition of capacity over time.

19. The ultrasonic diagnostic device of Claim 16, further comprising a probe,

wherein at least one of the image display means and the measurement display means integrates with the probe.

20. The ultrasonic diagnostic device of Claim 13,

wherein the automatic contour extracting means extracts a final contour from each of two ultrasound images corresponding to two cross sections that are orthogonal to each other, and

wherein the capacity calculating means uses each extracted final contour in an approximate expression to calculate a capacity, the approximate expression being pursuant to one of a modified Simpson method and a biplane area length method.

21. The ultrasonic diagnostic device of Claim 12, further comprising:

a real time control means for having an operation repeatedly performed at a fixed frame rate, the operation including: (a) generation of the ultrasound image; (b) the extraction of the final contour by the automatic contour extracting means; and (c) the calculation of the capacity; and

a moving image storing means for accumulating ultrasound images generated through the repeatedly performed operation to generate and store moving images for the object.

22. The ultrasonic diagnostic device of Claim 12, further comprising

a real time control means for having an operation repeatedly performed at a fixed frame rate, the operation including: (a)

generation of the ultrasound image; (b) the extraction of the final contour by the automatic contour extracting means; and (c) the calculation of the capacity,

wherein the real time control means includes a frame rate control unit for monitoring the operation and changing the frame rate to have the operation completely performed.

23. The ultrasonic diagnostic device of Claim 1, further comprising

an image normalizing means for normalizing the ultrasound image by converting density of pixels of the ultrasound image in such a way as to make a density distribution of the ultrasound image satisfy a predetermined condition,

wherein the automatic contour extracting means performs the predetermined operation on the normalized ultrasound image to extract the final contour.

24. The ultrasonic diagnostic device of Claim 23, wherein the normalizing means includes:

a condition storing unit for storing the predetermined condition in advance;

a density converting unit for converting the density of the pixels by using a plurality of transform functions to generate a plurality of ultrasound images; and

a control judging unit for specifying, out of the plurality of ultrasound images, an ultrasound image that satisfies the stored predetermined condition, and outputting the specified ultrasound image as a normalized ultrasound image.

25. The ultrasonic diagnostic device of Claim 1, further comprising

a contour correcting means for correcting the final contour

extracted by the automatic contour extracting means in accordance with either dialog with an operator or a standard that the contour correcting means stores.

5 26. The ultrasonic diagnostic device of Claim 25, further comprising

10 a use ascertaining means for determining, for one of the extracted final contour and the corrected final contour, whether the final contour is used for subsequent operation in accordance with dialog with the operator.

27. The ultrasonic diagnostic device of Claim 26, further comprising

15 an automatic capacity calculating means for calculating a capacity of the object by using the final contour determined to be used by the use ascertaining means.

28. The ultrasonic diagnostic device of Claim 27, further comprising

20 a three-dimensional (3D) image generating means for accumulating each final contour determined to be used so as to generate and display a 3D image for the object.

25 29. The ultrasonic diagnostic device of Claim 25, further comprising

an automatic capacity calculating means for calculating a capacity of the object by using the corrected final contour.

30 30. The ultrasonic diagnostic device of Claim 25, further comprising

a 3D image generating means for accumulating each corrected final contour to generate and display a 3D image for the

object.

31. The ultrasonic diagnostic device of Claim 1, wherein the automatic contour extracting means extracts the contour by using previously extracted contours.

32. The ultrasonic diagnostic device of Claim 31, wherein the automatic contour extracting means extracts the contour by performing an operation using the contours which have been previously extracted from ultrasound images corresponding to a plurality of frames, the operation being at least one of: (a) interpolation into the frames; (b) OR operation being performed on each ultrasound image for which binarization has been conducted; (c) AND operation being performed on each ultrasound image for which binarization has been conducted; and (d) estimation of movement.

33. An ultrasonic diagnostic device that generates and displays an ultrasound image containing an object which is subject to examination in accordance with reflection of ultrasound, the ultrasonic diagnostic device comprising:

an automatic contour extracting means for extracting a contour of the object from the ultrasound image by performing a predetermined operation on the ultrasound image; and

a three-dimensional (3D) image generating means for accumulating each generated contour to generate and display a 3D image for the object.

34. The ultrasonic diagnostic device of Claim 33, wherein the automatic contour extracting means extracts the contour of a left ventricle of a heart from the ultrasound image and wherein the 3D image generating means displays the 3D

image for the left ventricle.

35. The ultrasonic diagnostic device of Claim 34,
wherein the automatic contour extracting means extracts the
5 contour of a fetus from the ultrasound image and
wherein the 3D image generating means displays the 3D
image for the fetus.

36. The ultrasonic diagnostic device of Claim 33, wherein for
10 performing the predetermined operation, the automatic contour
extracting means includes:

an initial contour extracting unit for roughly extracting an
initial contour of the object; and

a dynamic contour extracting unit for accurately extracting a
15 final contour by using the extracted initial contour as an initial value
and by applying an active contour model to the object within the
ultrasound image.

37. An image processing device that extracts a contour of an
20 object that is subject to examination from an image, the image
processing device comprising:

an initial contour extracting means for roughly extracting an
initial contour of the object by performing a predetermined
operation on the image; and

25 a dynamic contour extracting means for accurately extracting
a final contour of the object by using the extracted initial contour as
an initial value and by applying an active contour model to the object
within the image.

30 38. A program used by an ultrasonic diagnostic device that
generates and displays an ultrasound image containing an object
which is subject to examination in accordance with reflection of

ultrasound, the program including:

an initial contour extracting step for roughly extracting an initial contour of the object by performing a predetermined operation on the ultrasound image; and

5 a dynamic contour extracting step for accurately extracting a final contour of the object by using the extracted initial contour as an initial value and by applying an active contour model to the object within the ultrasound image.

10 39. A program used by an ultrasonic diagnostic device that generates and displays an ultrasound image containing an object which is subject to examination in accordance with reflection of ultrasound, the program including:

15 an automatic contour extracting step for extracting a contour of the object from the ultrasound image by performing a predetermined operation on the ultrasound image; and

a three-dimensional (3D) image generating step for accumulating each generated contour to generate and display a 3D image for the object.

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40. A program used by an image processing device that extracts a contour of an object that is subject to examination from an image, the program including:

25 an initial contour extracting step for roughly extracting an initial contour of the object by performing a predetermined operation on the image; and

30 a dynamic contour extracting step for accurately extracting a final contour of the object by using the extracted initial contour as an initial value and by applying an active contour model to the object within the image.